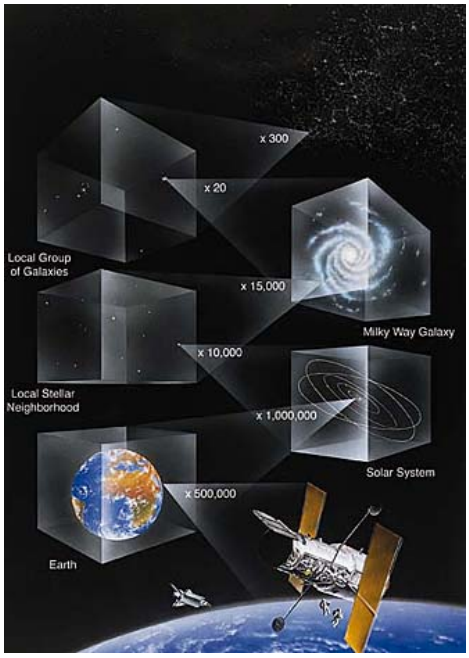
Where the Galaxies Are And When Galaxies Collide

First, let us recall the scale of the universe and its structures…



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Structure Hierarchy

- stars are clustered in galaxies
- galaxies are clustered into galaxy groups
- galaxies groups form "poor galaxy" clusters
- galaxy clusters form superclusters

- some clusters are called "rich clusters"- these are not comprised of groups, but are simply large, galaxy filled clusters. At their centers are giant E galaxies.

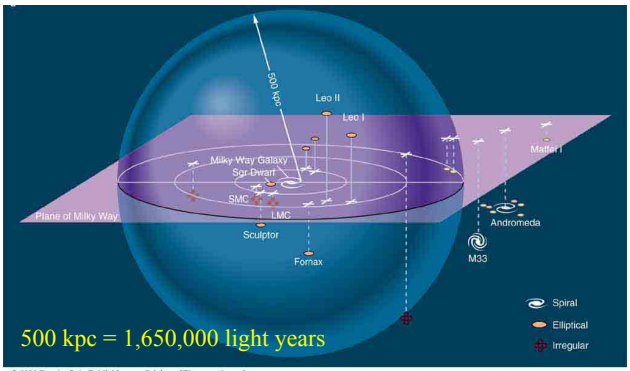
- the irregularly shaped "poor clusters", with less than 1000 galaxies, are comprised of subcondensations, or small groupings (i.e. groups).

2

The Local Group

Our Local Group is composed of :

- Two large spirals (MW & Andromeda)
- A moderate sized spiral (M33)
- 30 odd dwarf elipticals (Leo I & II, Fornax…)
- A few irregular galaxies



Small Groups like our Local Group are very common in the universe. These small groups add up to form larger coherent structures, including super clusters.

However, some galaxies are not members of small groups, but of the large clusters themselves.

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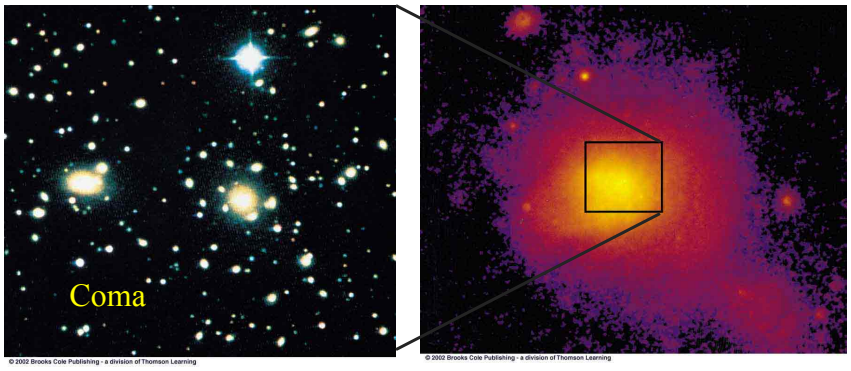
Large (or "Rich") Galaxy Clusters



The centers often have large E galaxies.

The cluster sizes can be up to 3 Mpc, or 10 million light years.

This is an image of the cluster "core".

An expanded field of view in this X-ray image shows that rich clusters often have hot gas (10 million K) smoothly spread out. This gas is metal enriched and indicates a mass much greater than that of just the galaxies. DARK MATTER?

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The Wonderful World of Colliding Galaxies.

Yes. Galaxies collide all the time. Some in the centers of cluster. Some in the the "field" (far small groups or away from clusters).

Note that the stars never actually hit each other, but the gas acts like a viscous fluid on a grand scale of 100,000 light years.

The below web link (you can click on it) send you to a gallery of bizarre galaxies.

http://www.nrao.edu/astrores/HIrogues/webGallery/

The neutral hydrogen gas (HI) in galaxies can extend out to 10 times the size of the stellar components! This gallery has some unbelievable pictures.

What you are looking at is the stars (left panels in black on a white sky). The right panels have blue contours of the neutral hydrogen gas.

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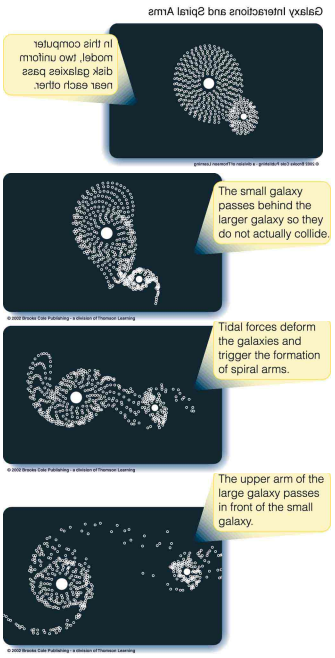
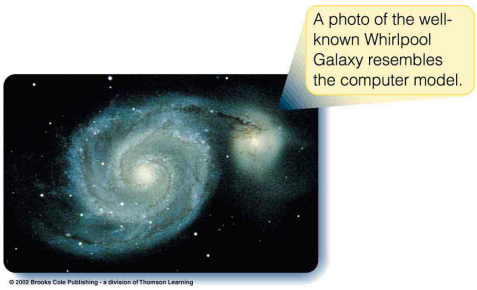


The Whirlpool Galaxy

An act of Galactic Cannibalism!

Computer simulations provide an accurate, and entertaining, insight on galaxy mergers.

This cartoon reveals a possible scenario for the formation of the beautiful Whirlpool Galaxy.



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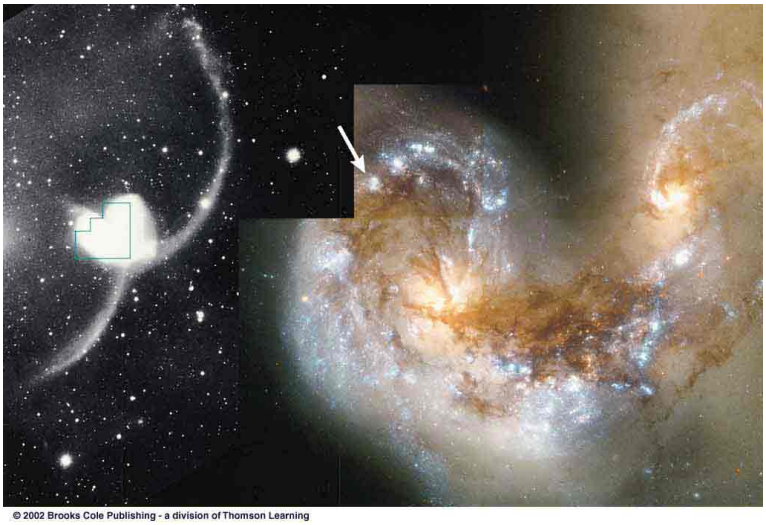
Galaxy Collisions viewed in the Era of Space Telescope!



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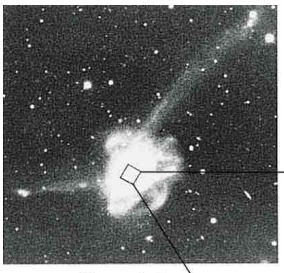
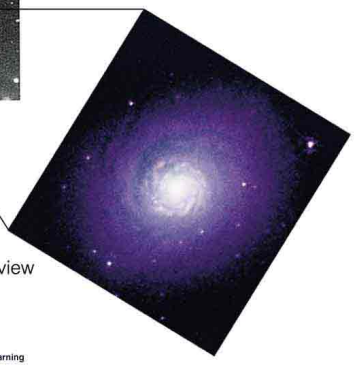
Counter rotating Gas in the Core Reveals Odd Trends



Ground view

Another typical galaxy collision showing the tall-tale stellar tails whipping out and falling back in. But…

A Space Telescope image of the gas (in emission) reveals an inner gas disk. The rotation direction of this disk is opposite that of the main body of stars!



HST view

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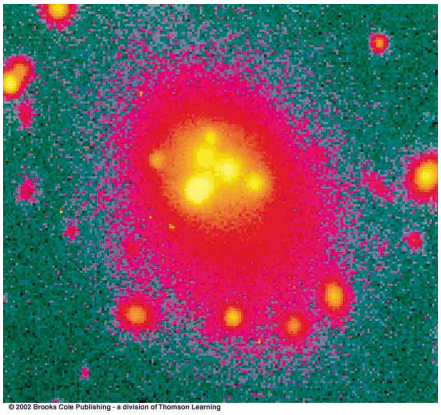
Multiple Nuclei in E Galaxies



The giant E galaxies in the cores of large galaxy clusters often have multiple nuclei. This suggests that these giant E galaxies are built up by cannibalizing unsuspecting cluster members who come too close to the center! The nuclei will eventually merge.

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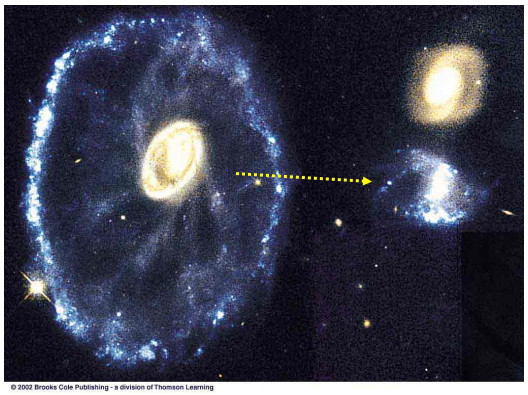
Ring Galaxies

High speed, single-pass, collisions sometimes occur and this can create a new "burst of star formation. In this case, the compression wave moved out like a outward ripple in a pond and created a ring of new stars!



These particular two galaxies will never strike each other again.

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Hierarchical Clustering

A big big question in astronomy has been…

Do galaxies form first and then do they coalesce (gravitationally) into groups, following which groups form clusters and clusters form superclusters?

Or

Do supercluster mass sized objects form and then the subcondensations in them form into clusters, then into groups, and then the galaxies form?

What do you think?

To date, we think galaxies formed first and then built up… more on this later.

This is called hierarchical clustering. It depends upon what dark matter is.

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